The Role of AI and IoT in Healthcare for the Elderly [Diabetes and Covid-19 as a model]: Literature Review

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Abstract

Recent challenges in the medical field have emphasized the need to exploit new technology, starting with the production of medicines and medical devices, to electronic medical service technologies, electronic archiving of medical records, and even the use of intelligent devices to communicate with patients and tracking their health status in real-time. The most significant impact is attributed to technological fields of all kinds and forms, including cloud computing technologies, robots, sensors, Artificial Intelligence, and the Internet of Things, the last two fields have contributed to serving the health care field from a variety of clients, most notably the elderly. This paper presents two diseases which are [Diabetes and Covid 19] by reviewing the latest research published in recent years in this field of healthcare, analyzing and categorizing through comparison tables to discover their strengths and weaknesses and judge them fairly.

1. Introduction

The health care field for the elderly and disabled people is witnessing great global growth due to the Corona pandemic, which forced people all over the world to stay at home, and this has positively affected in highlighting the importance of medical technological tools that can be available at home, especially for those who need special care for their health situation.

Since the elderly suffer from many diseases, including (vision problems, diabetes, high blood pressure, cancer, anemia, kidney failure, Alzheimer's, and heart disease) and here, there is a need to add technology capabilities to serve this segment of people by creating tools through which they can monitor their vital signs [1] according to their diseases and health status. First, we should define PSA which stands for "primary self-care actions", and it is a measure of an aged person's ability [2] which can be summarized in clothing, shaving, mobility, eating as shown in Fig. 1.

Fig 1. Human's PSA

The use of the bathroom is an example of normal behaviors that individuals have acquired from an early in life and generally accomplish frequently without help. As a result, this expression is often used by caregivers to identify which seniors require additional assistance. Global population growth and rising medical costs are negatively affecting medical systems around the world. If things continue as they are, they may soon become unsustainable. thus, artificial intelligence might be used as a valid solution [3]. Technology can enhance healthcare outcomes and results.

The review is organized as follows: Section 2 delivers a concept presentation of the artificial

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intelligence (AI) and its definitions and techniques, Section 3 presents the Internet of Things (IoT). Section 4 provides the relationship between AI and IoT by showing the main differences between them, Section 5 provides the concept of IoMT. Section 6 presents the Combining AI, IoT in the Medical field it provides the review of diabetes and covid19 by analyzing and judging. Section 7 concludes the paper.

2. Artificial intelligence

2.1. AI definition and historical view

AI refers to technologies or machines that behave like humans and can develop automatically based on the statistics they collect. There are a variety of machine learning methods [4] available. Here are a few examples:

- AI can make automatic television show suggestions based on a person's watching behavior.
- To enhance work schedules, AI utilizes it to assess vital information from a vast quantity of text data.
- AI systems are used by chat robots to better comprehend consumer concerns and give more effective responses.

AI is used by chatbots to better comprehend consumer concerns and give more effective responses. To enhance work schedules, AI technology has evolved into a grab concept for systems that execute complex activities that formerly needed human input, such as conversing with clients via the Internet. Deep learning is a subfield of machine learning which in turn is considered a subset of artificial intelligence [5]. However, the AI have several benefits in healthcare domain such as:

- Improving Clinical decision-making.
- Artificial intelligence-assisted surgery.
- Human errors reduction.
- Decreasing medical costs.
- Improve performance and efficiency

2.2. The Applications of AI medical care

AI has many potentials that are related to human wellness, which is reflected in death and life circumstances. While still have much to conquer to achieve AI-assisted medical services, many noticeably data privacy concerns as well as fears of unmanaged care caused by mechanical inaccuracy as well as a level of personal supervision, there is plenty of chance to integrate IA to the healthcare problems. Government agencies, medical suppliers, and technology corporations are interested in investing [6] in and testing intelligent instruments. It seems to be four AI innovations in healthcare hold the most future potential as displayed in bellow Fig. 2.

2.2.1 Assist in clinical decision-making or diagnosing

To be sure, applying AI to make an accurate diagnosis is still in its early stages, however, there are some promising

application cases. Stanford University research pitted an AI system against dermatologists to diagnose skin malignancies and is performed on an equal level with humans [7]. A Danish AI software startup put its deep-learning technology to the test by allowing software listening in while human handlers answered emergency calls [8]. The program examined what a speaker said, imprint tone of voice, back noise, and diagnosed cardiac arrests with a high success rate.
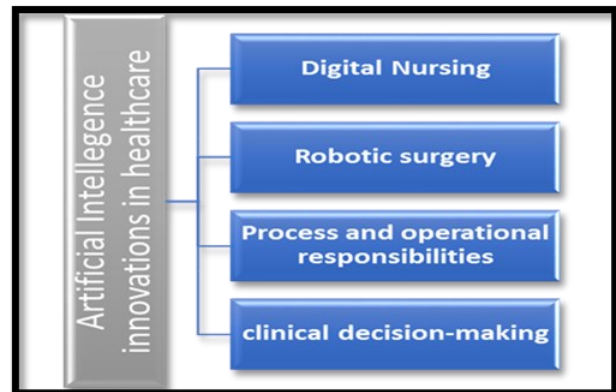

Fig 2. Artificial Intelligence Applications in Healthcare sector

2.2.2 Process and operational responsibilities

Some other AI approaches that might benefit healthcare are through simplifying administrative duties. This is expected to save the medical industry billions of dollars since technology will help health care providers, caregivers, and other experts reduce time on routine tasks. Voice-to-text translations, for example, could help with test ordering, medication writing, and graph note writing. Analyzing large data and assisting clinicians to offer a tailored and more effective treatment service is an example of applying AI to support administrative activities.

2.2.3 Robotic surgery with AI support

Robots may evaluate the data of medical files to guide a surgeon's tool before surgery, which can reach almost 28 percent of time minimizing in a patient's hospital accommodation [9]. that's because automaton surgery is simple to operate on, patients will no longer be needed to heal from huge incisions. Robots may utilize information from existing steps to inform future surgical approaches using AI. The most modern surgical robot allows doctors to execute difficult surgeries with a minimum ratio of fail than traditional ways. "Heart surgeons are aided with the Heart-lander, a little robot that penetrates the body through a tiny hole and performs mapping and treatment on the heart's wall" [10].

2.2.4 Digital Nursing:

By communicating with patients, virtual nursing assistants could save billions of dollars annually for the healthcare sector. They could place patients in appropriate care environments. Because virtual nurses are

accessible 24 hours a day [11], they can answer queries, assist doctors, and give timely responses. A virtual nursing assistant system enables caregivers and patients to communicate more constantly during office visits, reducing hospital readmissions and unnecessary hospital stays. Artificial intelligence and speech recognition are used to perform health checks by Care Angel's virtual nursing assistant.

2.2.5. Surgical robotics.

Robotic surgery, known as robotic surgery, lets surgeons perform a variety of procedures (complex cases with more precision, adaptability, and efficiency over traditional methods). Surgical Robotics is sometimes connected to microsurgery; this is done through tiny holes used in many traditional open surgeries operations. Clinically advanced robotics [12] usually consists of a camera arm plus artificial arms with surgical instruments attached. The surgeon uses the arms while sitting at a computer workstation next to the treatment table. A dashboard displays a high-definition and enlarged. The doctor has shown a 3-D image of the surgical location. The surgeon directs the other colleagues who assist during the process.
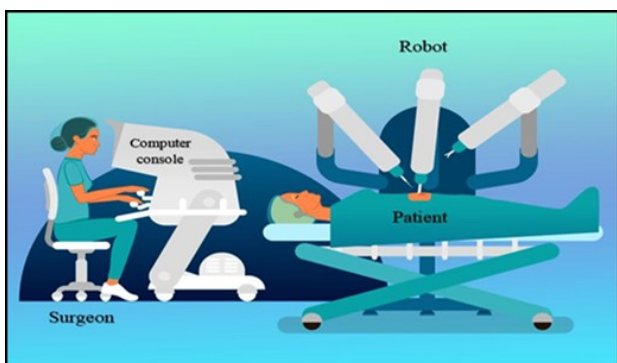

Fig 3. Surgical robotics component

Benefits of Surgical Robotics
- There will be fewer consequences, such as surgical site infection.
- Pain and blood loss are reduced.
- Improved healing time.
- Relatively small, less visible scars.

3. Internet of things.

It is an interconnection computing device, with the ability to move and manipulate, items, living creatures, or individuals that have unique identification numbers as well as the possibility to exchange data with no need for people interaction. the exchange of data through the four different technologies [13] illustrated in Fig. 4.
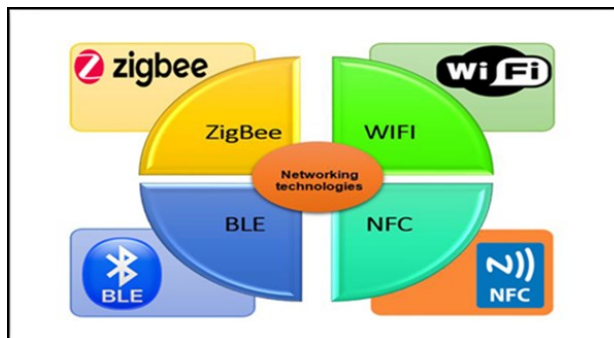

Fig. 4. Types of IoT communication technologies

3.1. IoT definition.

Oxford Dictionary defines IoT as:" the connection of devices within everyday objects via the internet, enabling them to share data". To discuss IoT, it can be useful to outline the most essential capability elements. In its most basic form, IoT can be thought about as a wide range of network objects supported by:

- Detector: used to gather data.
- Identifiers: used to find the location of information.
- Data interpreting software
- Web access: for connection and monitoring

Internet of Things is defined as a collection of things or physical devices that interact with one another via the web through a set of software and sensors. This technology has a wide range of applications (electrical networks, medical assistance, intelligent home, smart cities…etc.) as shown in figure (5).

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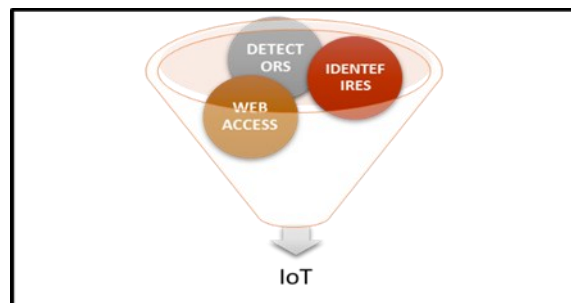

Fig. 5. IoT simple Element

3.2. IoT impact on the medical care field.

This section describes how the Internet of Things affects the health care sector:

- By reducing the response time for critical illness cases, especially for elderly people.
- By reducing the costs that the patient has to pay as part of his periodic reviews of the hospital.
- Continuous and periodic updating of the patient's electronic medical file and sharing it with medical staff (doctors, nurses, and people related to the patient).
- Improving diagnostic techniques and thus increasing the efficiency of treatments and medicines given to the patient for example in [14] Authors proposed assisted IoT enabled disease diagnosis framework for the m-health perspective.

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4. AI vs. IoT:

The Internet of Things technology is currently considered one of the most crucial and promising fields that can be developed and invested in, especially in the medical field, because it focuses on connecting all things, starting from our bodies to our homes and devices,

5. Internet of medical things (IoMT)

It's a subsection of (IoT) [14], The based clinical experience almost certainly involved some kind of medical device or gadget - whether it was a blood pressure meter, glucometer monitor, or MRI device. There are a lot of medical innovations available today, with today's linked gadgets meant to improve effectiveness, reduce spending, and offer better treatment.

Fig. 6. Internet of Medical things

especially medical devices [15]. artificial intelligence Makes machines and devices more intelligent and interactive by simulating human intelligence to collect the required data through sensor networks. in addition, these two technologies began to fade and disappear. Some clear essential differences can be included in the table below.

Table (1). IoT vs AI

Internet of Things	Artificial Intelligent
IoT relates to a network of interconnected objects linked to the web.	AI is a subfield in computer science that seeks to build devices that can perform intelligent tasks.
Dependable on AI	Undependable on IoT
Fitness trackers, health monitoring devices, factory organization, wearable technologies, parking management, water management, and energy monitoring are some of the uses.	Deep learning, natural language processing, automation, voice recognition, and machine vision all fall under the umbrella of artificial intelligence.
IoT allows devices and objects to exchange information over the web without the need for human contact.	Artificial intelligence (AI) simulates human behaviour and cognition in robots to make them respond more humanely.

a networked platform of medical equipment, software solutions, medical systems, and applications. The latest generation of sensor-based gadgets, including wristbands and equipment for healthcare monitoring, together with the mix of linked medical equipment and a wealth of patient data, distinguishes the IoMT from the other IoT systems. Its growth is being fueled by a growing number of linked medical devices that create, gather, evaluate, and transfer files. So, it is possible to say that this field is a meeting point between the Internet of Things and the technology and tools of artificial intelligence, as in Fig. 6 above.

6. Combining AI, IoT in the Medical field:

The impact of integration between the AI and IoT is evident in many studies and research, it will be categorizing them according to disease type into 6 sub-sections which are related to elderly or disabled people's health which many studies are analyzed and discussed in next tables.
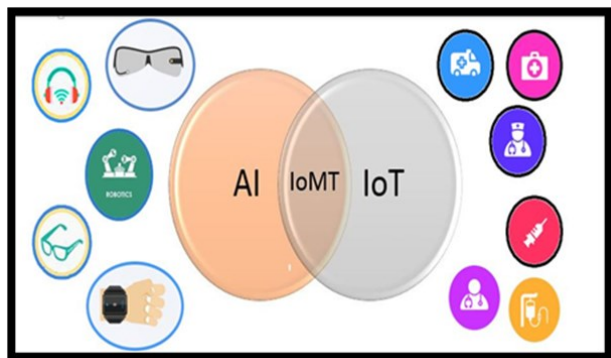
6.1 Diabetes.

WHO stated [15], "About 422 million people worldwide have diabetes, the majority living in low-and middle-income countries, and 1.5 million deaths are directly attributed to diabetes each year". The impact of diabetes is increasing on the elderly and people with disabilities, in addition, diabetes causes many complications, as in figure (7).

Companies are understanding the possibilities of the Internet of Medical Things as computer power and connections grow. With their capacity to gather, analyze, and broadcast health data, IoMT instruments are quickly transforming many health care facilities. They enable medical practitioners to detect and avoid concerns such as infectious conditions, as well as provide appropriate care even in remote regions. (IoMT) is

Through the table below, studies will be analyzed, some of which aimed at diagnosing the disease through artificial intelligence devices and technology, which will be analyzed in table 2.

After reviewing the studies and research covered in the table above, concerning diabetes and its complications, it is clear that studies that included models

in which artificial intelligence technology was applied coupled with the Internet of Things were applied using (naïve Bayes, J48, sequential minimal optimization (SMO), ZeroR, OneR, simple logistic, and random forest). but it still shows that some of the studies were analytical and statistical, which affirmatively highlights the need to delve into this field in the future.

Fig. 7. Diabetes Complications [15]

Table (2). Integration of AI and IoT for Diabetes

AUTHORS & REF. NO	RESEARCH PURPOSE		PERFORMANCE METRICS		TECHNOLOGIES	LIMITATIONS	USING IOT	USING AI
	PAPER TYPE	TASK	ACCURACY	DELAY TIME				
Amine Rghioui et al. [16]	Experimental Research Paper	smart continuous monitoring of diabetic patients using a machine learning algorithm for data classification	SMO algorithm 99.66%	/	5G, blood glucose sensors, Arduino	Bandwidth, high energy efficiency	√	x
Amine Rghioui et al. [17]	Experimental Research Paper	developed a small portable device capable of measuring the level of glucose in the blood for diabetics	J48 ML algorithm 99.17%	/	Bluetooth, WIFI, 4G Arduino Uno, Glucose Sensor	Adding a galvanic skin response (GSR) sensor	√	√
Martina Vettoretti et al. [18]	Review Paper	using CGM sensors for decision support in advanced type one diabetes management	/	/	DSS, R2R Algorithms	Insulin sensitivity and possible errors occurring in the insulin pump	x	√
Francisco Valenzuela et al. [19]	Experimental Research Paper	Using new techniques for detecting, the highs and lows of glucose levels	/	33.96%	Raspberry Pi, WIFI, Node MCU	Limitation of wireless technologies	√	√
Ram D. Sriram et al. [20]	Review Paper	Using AI to diagnose diabetes	/	/	The artificial pancreas, Retinopathy Detection, CGM	The artificial pancreas, (closed-loop systems)	√	√
Haick et al. [21]	Review Paper	Using AI in Skin-based wearable devices to diagnose diabetes	/	/	PCA, SVMs, DTs, ANNs, CNNs, AI, ML, GSR	The difficulty of separating target signals from background noise	√	√
Kai Siang Chan et al. [22]	Survey Research Paper	Monitoring Diabetic Foot Ulcers (DFU) using Wound Imaging Systems.	80% to 90%	/	Systematic Reviews and Meta-analyses (PRISMA) optical imaging, spectroscopy	A huge collection of wound photos is required to improve the machine learning model's accuracy.	x	√
Lefan Wang, et al. [23]	Review Paper	It shows recent advances in stress sensing and plantar pressure for DFU	/	/	(Piezoelectric, Capacitive, Fiber-optic, Resistive, Wireless) sensors	it lacks multiaxial measurement, its prohibitively expensive for routine clinical use.	x	√

AUTHORS & REF. NO	RESEARCH PURPOSE		PERFORMANCE METRICS		TECHNOLOGIES	LIMITATIONS	USING IOT	USING AI
	PAPER TYPE	TASK	ACCURACY	DELAY TIME				
Samer Ellahham et al. [24]	Review Paper	The detection of diabetic retinopathy and macular edema through AI and Machine learning	/	/	Artificial neural networks, support vector regression (SVG)	cost, access, implementation also Endpoints need to be redefined to include the digital biomarkers	√	√
Luca Greco et al. [25]	Review Paper	Paper focusing on systems addressing health monitoring problems through fog/edge computing	/	/	fog/edge computing, wearable sensors	power and storage	√	√
Revital Nimri et al. [26]	Experimental Research Paper.	the application of an automated DSS tool to optimize insulin pump settings	$50.2 \pm 1.1\%$	/	AI-DSS, CGM,	Time and cases numbers	x	√
Jyotismita Chaki et al. [27]	Review Paper	Using AI-based intelligent assistants for automatic diabetic detection and diagnosis techniques	CT score of 75.3%	/	SVM, DSS, CT	unsuitable data management	x	√
Ilia V. Derevitskii et al. [28]	Analytical Research Paper	This study demonstrated the critical role of prescribers in the management of diabetes patients.	94-99%	/	Graph-based dynamics analysis, XGB model	Model quality and period	x	√
Bridget J. Daley et al. [29]	Review Paper	Using mobile Health applications through clinical DSS or AI for diagnosing GDM	/	/	CDSS, AI	Quality and availability of medical data, doctors resistance to AI	√	√
Giang Thu Vu Et al. [30]	Analytical Research Paper	adopting a combination of bibliometric approach and complex analysis of AI application in diabetes	/	/	PCA, LDA, EFA, WOS classification	lack of mathematical model validations, privacy, and confidentiality	x	√
Kai Siang Chan et al. [31]	Compare and Contrast Paper	Validating clinically an artificial intelligence-enabled wound imaging mobile application	95%	/	C4W devices,	Paucity of existing studies, Inadequate measurement of the typical length of wounds	x	√

6.2. Covid - 19.

Since Dec 2019 the world suffers from Covid 19 and declare a public health emergency, WHO says that more than 426 million people was infected worldwide until feb2022[32] as seen in Fig. 8, a study in china by "Statista" web site which provides statistics and survey results for 44672 infected persons on Feb 11, 2020 [33], it shows that fatality rate rising for elderly people from coronavirus as shown in fig (9), many studies show to use IoT, AI technologies to diagnose or detect virus infected people as seen in table (3).Initially, 134 published research papers were selected related to the general topic of this research as in [44], who uses IoT techniques and artificial intelligence tools in the medical fields. Those researches were filtered and excluded according to the problem issues that discussion.

Table (3). Integration of AI and IoT for Covid 19

AUTHORS & REF. NO	RESEARCH PURPOSE		PERFORMANCE METRICS		TECHNOLOGIES	LIMITATIONS	USING IOT	USING AI
	PAPER TYPE	TASK	ACCURACY	DELAY TIME				
Ahmed Barnawi et al. [34]	Experiment Paper	Designing an IoTUAV system that uses a Thermal Drone (TCCD) to autonomously detect the COVID-19 with nearly no human interaction.	99.5%	/	TCCD, Face Detection, blockchain, 6G	current version deployed an offline scheme	√	√
Wu He et al. [35]	Analytical Research Paper	It assesses technology applications targeting COVID-19 nature using the data, people, system framework and proposes	/	/	Robotics, big data, ML, DL, blockchain	prohibit the misuse of user data, the enhancement of design and development	√	√

| AUTHORS & REF. NO	RESEARCH PURPOSE		PERFORMANCE METRICS		TECHNOLOGIES	LIMITATIONS	USING IOT	USING AI
	PAPER TYPE	TASK	ACCURACY	DELAY TIME				
Samyadip Chakraborty [36]	Review paper	highlights that adoption of Internet of things (IoT)- enabled wearables/devices and application	/	/	Wearable devices,	No suitable scale for standardization.	√	√
Mohamed Abdel-Basset et al. [37]	Review paper	assist the healthcare team in making timely choices for the treatment of COVID-19 people with chronic conditions in hospitals	/	/	IoMT, Drones, VR, 5G, Blockchain	/	√	√
Angelos-Christos Daskalos et al. [38]	Experimental paper	The research presented a wearable gadget that detects body temp and environmental factors in real-time.	/	/	CDA Algorithm, Low energy 5.0 BLE protocol, Arduino Nano 33	Battery life	√	√
Farshad Firouzi et al. [39]	Review paper	It highlights four technologies to which IoT may contribute, including (RPM, WIoT, PDT, tracking and tracing)	/	/	DLT و blockchain, ECGs, NLP,	Limited route information,	√	√
Shovon Bhowmick et al. [40]	Experimental paper	it offers An IoT-based platform, as well as prediction of COVID-19 infection.	92.05-94.83%	/	Raspberry Pi, ML, SVM, XGBoost;	Model doesn't used a real-life data, authors were unable to develop a real wearable system, so they created a prototype.	√	√
Minsoo KANG et al. [41]	Experimental paper	a single elderly care system comprised of an 8-inch monitor-based controller with an IoT sensors capable of detecting a fall in real-time	99-100%	/	FES, HADS,	Cost	√	√
Kun Qian et al. [42]	Review paper	It summarizes the primary IoT modalities for the elderly based on their Audio and Video signal characteristics.	90%	/	DCNN, NB, SVM, k-NN, DT, FNN	Data scarcity,	√	√
Geetanjali rathee et al. [43]	Experimental paper	It presented different smart IoT-based techniques and machine learning (ML) for classifying COVID-19 patients.	79.62% - 90.27%	/	BP, Viterbi, BR, algorithms	/	√	√
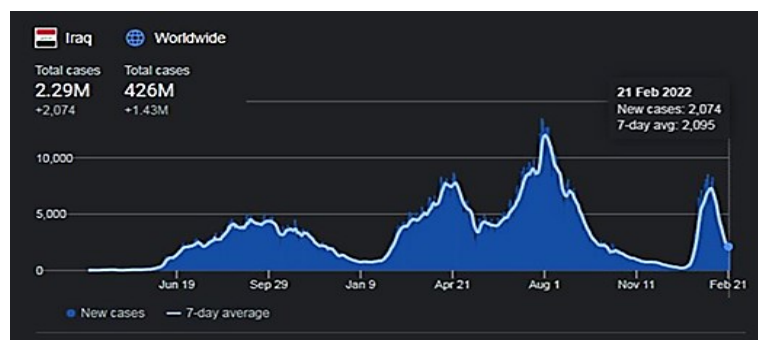
Fig. 8. Covid 19 infection count

Conclusion

In light of the urgent need for technological healthcare solutions, this paper presented a technical review of valuable research papers to help this target group of patients (the elderly and disabled people) by reviewing many of the techniques that have been defined, analyzed, and distinguished. By reviewing this literature, it became clear that some of the artificial intelligence tools were used in integration with some types of modern networks and communication technologies such as the fifth-generation network in the discovery and diagnosis of these two diseases, such as some of the machine language algorithms and the Internet of Things. Despite that, many of these studies neglected the use of some of the Neural network tools.

Conflict of interest

A conflict of interest statement must be placed at the manuscript as below: "The authors

declare that there are no conflicts of interest regarding the publication of this manuscript".

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